Specific Health Effects Associated with the Sulfur Mustard (HD) Acute Exposure Guideline Levels (AEGLs)

Background - AEGLs

Acute Exposure Guidelines Levels (AEGLs) are concentrations of a chemical in the air above which different health effects could begin to occur amongst the more sensitive (susceptible) members of the general population. AEGLs are being developed for hundreds of toxic industrial chemicals as well as chemical warfare agents. They are developed by the National Advisory Committee (NAC) for AEGLs, reviewed by the National Research Council (NRC) Committee on Toxicology, and are federal guidance for the assessment and management of short *one-time exposure incidents* (accidents or intentional terrorist attacks) involving releases of chemical gases. Unlike any other toxicity values for emergency response, AEGLs are established for multiple exposure periods ranging from minutes to hours (10 min, 30 min, 1 hr, 4 hr, and 8 hr).

The NAC derives AEGLs using a procedure recommended by the NRC[1]. This process begins with a set of generically defined health effect levels as represented below. Data for each chemical are evaluated and the types of health effects caused by a chemical are selected to fit in one of the 3 categories. The ultimate AEGL values that are derived are protective (safe-sided) estimates of where higher levels can begin to pose effects in some of the general population, including susceptible individuals such as children, persons with respiratory illness, and the elderly:

GENERIC DEFINITIONS OF AEGL LEVELS:

AEGL 1 – level above which non-disabling, reversible discomfort may begin to be noted.
AEGL 2 – level above which more serious effects may occur including possible long-lasting or escape-impairing effects.
AEGL 3 - level above which exposures may become life threatening or result in death.

These generic definitions, however, do not always provide adequate information to risk managers, as the actual health effects associated with individual chemicals may be less or more significant than assumed.

This Fact Sheet is designed to provide a more specific explanation of the actual types of health effects associated with the various AEGLs for Sulfur Mustard depicted in the Table on the next page.

Background – Sulfur Mustard

Sulfur mustard was one of the first chemicals specifically designed for military warfare. When pure it is referred to as HD (distilled mustard), but it can be found as mixtures with other chemicals. It causes adverse effects on the human body when absorbed by warm, moist tissues (e.g., eyes, skin, and lung) where it damages cells and causes cell death. At high enough air concentrations–or upon liquid contact –the cell damage can result in skin blisters and chemical burns. HD is unique because the effects occur hours to days after the exposure. As a result, individuals may not realize that they have been exposed. Though often called "mustard gas," HD is typically an oily liquid. However, in warm conditions or those involving explosions, it can vaporize and spread in the air. There are seven chemical warfare agent (CWA) stockpiles that contain HD in the U.S. The stockpiles are very old and are now undergoing destruction. However, the potential for terrorist use may still exist after the US stockpiles are destroyed. As a result, many Federal, State, and local emergency planners have identified the need for acute toxicity guidelines to incorporate into emergency and homeland security programs.

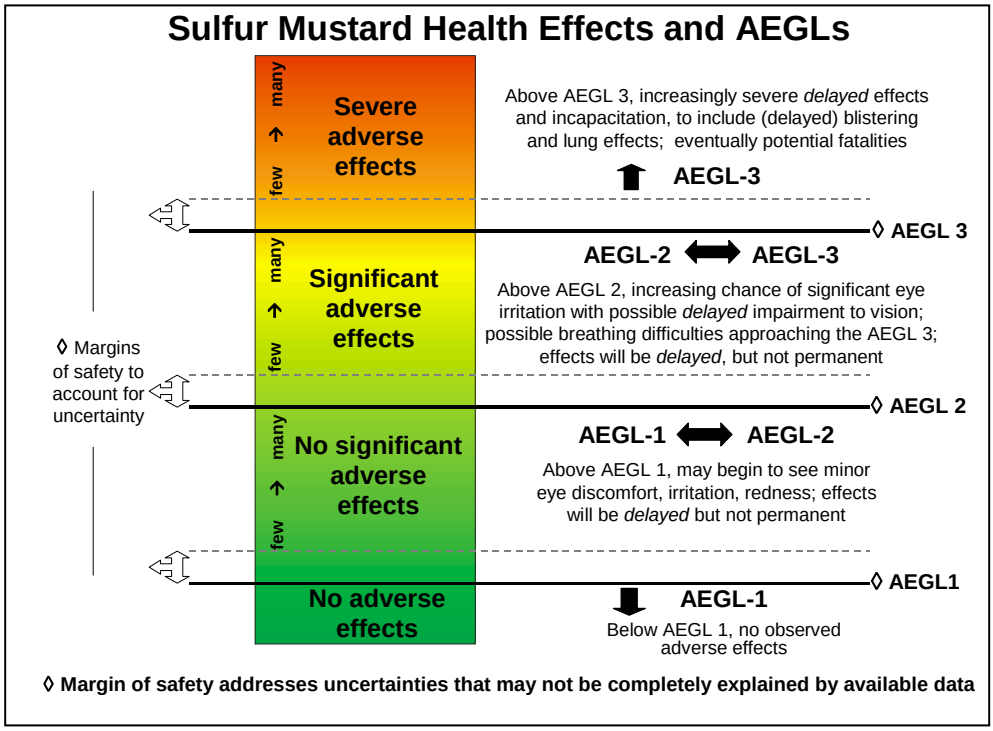
Health Effects Associated with Sulfur Mustard Agent AEGLs

The first effect from air exposure to sulfur mustard is mild eye irritation and redness referred to as "conjunctivitis." This effect is temporary and will disappear without treatment. This effect is delayed, however, so a person exposed to low levels of vapor may not notice the eye irritation until hours after the exposure has occurred. At higher concentrations, eye irritation can become more significant to include eyelid swelling and eye sensitivity to bright light, as well as potential burns to the skin or respiratory irritation (which could first affect those with respiratory illness such as bronchitis). However, in an environment with low concentrations of HD in the air, only the surface and tissues of the unprotected eye are affected. This endpoint is not associated with long-term effects on any other systems or organs of the body; there are no distinct susceptible sub-groups to this effect. Key points associated with each AEGL are summarized below:

• Sulfur Mustard AEGL 1 is the estimated initial concentration *above which* some members of the general population could potentially experience temporary mild eye redness and irritation. *This effect would develop only several hours after the exposure.* The estimated concentration for this effect is reduced by "uncertainty factors" (also known as "safety factors") to provide a "margin of safety" (a factor of 10 or more) which ensures that the AEGL 1 is very protective. It is possible that no one, including susceptible persons, would experience any effects at the AEGL 1 concentration. The Figure below shows how the margin of safety is incorporated into the AEGLs. No odors are detectable at this concentration.

• Sulfur Mustard AEGL 2 is the estimated initial concentration *above which* some members of the general population could begin to experience more significant levels of eye irritation/conjunctivitis, with some eyelid swelling and sensitivity to bright light. *These effects would develop only several hours after the exposure*. As with the AEGL 1, the estimated threshold concentration for this effect is reduced by safety factors to provide a margin of safety. This procedure provides a protective AEGL Level 2, which may result in some cases of mild, reversible, conjunctivitis. No long-term or permanent effects including excess cancer risk are expected to result from general public exposure at AEGL 2. No odors are detectable at this concentration.

• Sulfur mustard AEGL 3 is designed to protect against severely incapacitating effects such as (delayed) development of blisters on the skin as well as damage to the respiratory tract similar to that caused by inhalation of a caustic industrial chemical. Without treatment, such effects could lead to death. As with AEGLs 1 and 2, the estimated threshold for this effect is reduced by safety factors to provide a margin of safety. The result is a protective AEGL Level 3, which may result in some reversible incapacitation, but no deaths to the general public. Some odors may be noticed.



This figure depicts the gradation of expected proportion of people showing effects (few ➔ many) and the increasing severity in effects as air concentrations increase above each AEGL level. While the effects associated with the specific AEGL concentrations shown below have been critically evaluated, the exact degree of effects and number of persons affected at various concentrations *between* the AEGLs must be estimated using professional judgment.

Acute Exposure Guideline Levels	One time exposure duration :	*HD Concentration (mg/m^3)*
AEGL 1	10 MIN: 30 MIN: 1 HR: 4 HR: 8 HR:	0.40 0.13 0.067 0.017 0.0083
AEGL 2	10 MIN: 30 MIN: 1 HR: 4 HR: 8 HR:	0.60 0.20 0.10 0.025 0.013
AEGL 3	10 MIN: 30 MIN: 1 HR: 4 HR: 8 HR:	3.9 2.7 2.1 0.53 0.27

References and Additional Information:

1. National Research Council (2001). *Standing Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Chemicals*. Subcommittee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council. National Academy Press, Washington, D.C.
2. National Research Council (2003). *Volume 3, Acute Exposure Guidelines for Selected Airborne Chemicals, Acute Exposure Guideline Levels for Hazardous Chemicals*. Subcommittee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council. National Academy Press, Washington, D.C. www.nap.edu
3. *Basic Facts Regarding Chemical Standards and Guidelines*, USACHPPM 2006
4. *Frequently Asked Questions (FAQs) Regarding AEGLs and Their Application, USACHPPM 2006*
5. *Ready-Set-Act Fact Sheet: General Guidance Regarding AEGLs and CSEPP,* 2002

Additional Information/assistance: USACHPPM 410-436-1010

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